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(54) **Compact virtual image display.**

(57) A compact virtual image display (10) including an LED array (25) providing a real image, a bundle of coherent fibre optics (14) tapered to provide magnification and mounted adjacent the real image, and a lens system (18) mounted adjacent the bundle of fibre optics (14) to further magnify the image and produce a virtual image at a viewing aperture

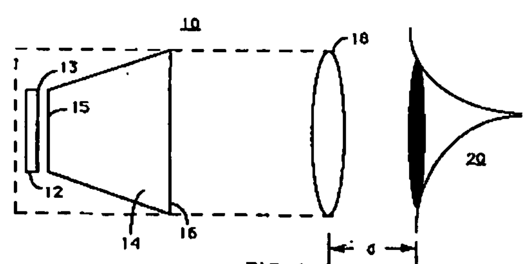

FIG. 1

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The present invention pertains, generally, to virtual image displays and more particularly to relatively high magnification compact virtual image displays.

Background of the Invention

Virtual image displays are becoming very popular in the present world of portable and very small electronic devices, such as pagers, cordless and cellular telephones, credit card calculators and palm-size computers. A virtual image display uses a lens magnifier to create a large virtual image from a small real image. As the real image becomes smaller and it is desired to make the virtual image larger, higher magnification lenses are required. However, higher magnification lenses in a virtual image display limit the field of view, eye relief and the working distance of the lens, which means the lens system must be very small and very close to the eye. At the present time, power of ten magnification (10x) lenses are relatively easy to produce with a reasonable eye relief, but magnification above 10x begins to restrict the packaging options.

Summary of the Invention

Solutions to these problems and other advantages are realized in a compact virtual image display having a viewing aperture, the display including apparatus for providing a real image, a bundle of coherent fibre optics defining a first and a second surface and tapered to provide a predetermined amount of magnification from the first surface to the second surface, the bundle of coherent fibre optics being mounted with the first surface positioned in juxtaposition to the real image provided by the apparatus, and a lens system mounted adjacent the bundle of coherent fibre optics to receive an image from the second surface thereof, further magnify the image and produce a virtual image at the viewing aperture.

An exemplary embodiment of the invention will now be described with reference to the accompanying drawings.

Brief Description of the Drawings

Referring to the drawings:

FIG. 1 is a simplified schematic view of a compact virtual image display constructed in accordance with a preferred embodiment of the present invention;

FIG. 2 is a simplified block diagram of electronics associated with the compact virtual image display of FIG. 1; and

FIG. 3 is an enlarged view in top plan of an LED array, portions thereof broken away, forming a portion of the electronics of FIG. 2.

Description of the Preferred Embodiment

Referring specifically to FIG. 1, a compact virtual image display 10 is illustrated in a simplified schematic view. Display 10 includes apparatus 12 for providing a real image on a surface 13. A coherent bundle 14 of optical fibres has a first surface 15 positioned adjacent the surface 13 of apparatus 12 and a second surface 16 defined at the opposite end of bundle 14. An optical system, represented by lens 18, is positioned in spaced relation to surface 16 of bundle 14 and, in cooperation with bundle 14, produces a virtual image viewable by an eye 20 spaced from an aperture defined by lens 18.

Apparatus 12 is illustrated in more detail in FIG. 2 and includes, for example, semiconductor electronics such as a light emitting diode (LED) array 25 driven by data processing circuits 27. Data processing circuits 27 include, for example, logic and switching circuit arrays for controlling each LED in LED array 25. Data processing circuits 27 include, in addition to or instead of the logic and switching arrays, a microprocessor or similar circuitry for processing input signals to produce a desired real image on a device such as LED array 25.

In this specific embodiment LED array 25 is utilized because of the extremely small size that can be achieved and because of the simplicity of construction and operation. It will of course be understood that other image generating devices may be utilized, including but not limited to lasers, LCDs, CRTs, etc. Referring specifically to FIG. 3, a plan view of LED array 25 is illustrated in which the LEDs are formed in a regular pattern of rows and columns on a single semiconductor chip 30. By addressing specific LEDs by row and column in a well known manner, the specific LEDs are energized to produce a real image. Digital or analog data is received at input terminal 28 and converted by data processing circuits 27 into signals capable of energizing selected LEDs to generate the predetermined real image.

It will be understood by those skilled in the art that LED array 25 and semiconductor chip 30 are greatly enlarged in the FIGS. The actual size of semiconductor chip 30 is on the order of a few milli-inches along each side with each LED being on the order of as little as one micron on a side. As the semiconductor technology reduces the size of the chip, greater magnification and smaller lens systems are required. Reducing the size of the lenses while increasing the magnification results in

greatly limiting the field of view, substantially reducing eye relief and reducing the working distance of the lens system.

Surface 15 of bundle 14 is positioned adjacent LED array 25 so as to pick up real images generated thereby and transmit the image by way of the optical fibres to surface 16. Bundle 14 is tapered along the length thereof so that the image at surface 16 is larger than the real image at surface 15. The taper in the present embodiment provides an image at surface 16 which is twice as large as the image at surface 15, which is equivalent to a power of two magnification. It will be understood by those skilled in the art that additional magnification (taper) may be included if desired.

The lens system, represented schematically by lens 18, is mounted in spaced relation from surface 16 of bundle 14 so as to receive the image from surface 16, magnify it an additional predetermined amount and create the aperture within which the virtual image is viewed. In the present embodiment, lens 18 magnifies the image another ten times (10x) so that the real image from LED array 25 is magnified a total of twenty times. It will of course be understood that the lens system may be adjustable for focus and additional magnification, if desired, or may be fixed in a housing for simplicity. Because the image received by lens 18 from bundle 14 is much larger than LED array 25, the lens system does not provide the entire magnification and, therefore, is constructed larger and with less magnification. Because of this larger size, the lens system has a larger field of view and a greater working distance.

Eye relief is the distance that eye 20 can be positioned from lens system 18 (the viewing aperture) and still properly view the image, which distance is denoted by "d" in FIG. 1. Because of the size of lens 18, eye relief, or the distance d, is sufficient to provide comfortable viewing and in the present embodiment is great enough to allow a viewer to wear normal eyeglasses, if desired.

Thus a greatly improved compact virtual image display is disclosed, which is used with an extremely small LED array, semiconductor chip display device, or any other suitable image source. The compact virtual display provides a predetermined amount of magnification without reducing the eye relief or the working distance of the lens system. Further, the electronics provided as a portion of the compact virtual image display allows a variety of very small real images to be generated, which can be easily and comfortably viewed by an operator.

Claims

1. A compact virtual image display (10) having a viewing aperture, the display characterized by:
   apparatus (12) for providing a real image;
   a bundle of coherent fibre optics (14) defining a first (15) and a second (16) surface and tapered to provide a predetermined amount of magnification from the first surface (15) to the second surface (16), the bundle of fibre optics (14) being mounted with the first surface (15) positioned in juxtaposition to the real image provided by the apparatus (12); and
   a lens system (18) mounted adjacent the bundle of fibre optics (14) to receive an image from the second surface (16) thereof, further magnify the image and produce a virtual image at the viewing aperture.

2. A compact virtual image display as claimed in claim 1 further characterized in that the bundle of fibre optics (14) is tapered sufficiently to provide magnification of at least a power of two.

3. A compact virtual image display as claimed in claim 1 or 2, further characterized in that the lens system (18) is constructed to magnify the image by a power of at least ten.

4. A compact virtual image display as claimed in claim 1, 2 or 3, further characterized in that the apparatus (12) providing the real image is formed in a semiconductor chip (30).

5. A compact virtual image display as claimed in any preceding claim, further characterized in that the apparatus (12) providing the real image includes a light emitting diode array (25).

6. A compact virtual image display as claimed in any preceding claim further characterized by image forming electronics (27) connected to the apparatus (12) providing the real image, the apparatus (12) producing the real image in response to signals received from the electronics (27).

7. A compact virtual image as claimed in any preceding claim, wherein the lens system (18) is a telescopic lens system, whereby the lens system is adjustable for focus and additional magnification.

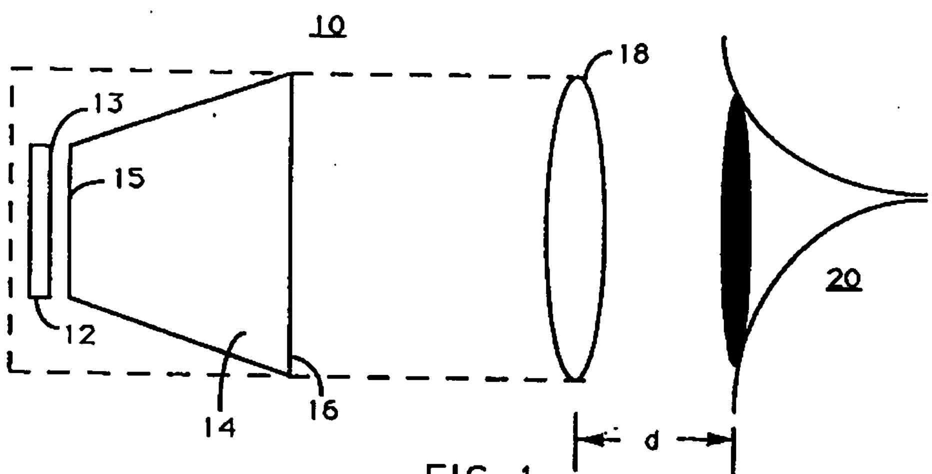

FIG. 1

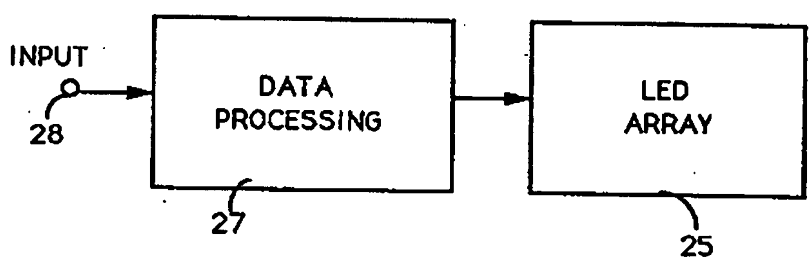

FIG. 2

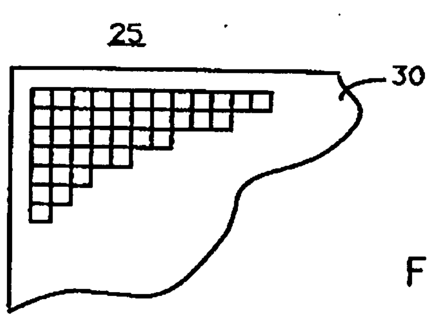

FIG. 3

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EUROPEAN SEARCH REPORT

Application Number

EP 92115263.3

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.5)
Y	EP - A - 0 425 371 (COMMISSARIAT A L'ENERGIE ATOMIQUE) * Fig. 1,2,3; claim 1; column 4, lines 22-25 *	1	G 09 F 9/30 G 02 B 6/06
A		2,4	
Y	DE - A - 3 434 355 (REIMER) * Fig. 5; claims 1,7,8 *	1	
A	DE - B - 2 437 580 (JENAER GLASWERK SCHOTT & GEN.) * Fig. 1,2; claim 1 *	1,2	
A	FR - A - 2 626 700 (DU CASTEL) * Abstract; fig. 1,2,3 *	1,4,5,6	
A	US - A - 4 465 347 (TASK) * Fig. 1,2,3; claim 1 *	1	

TECHNICAL FIELDS SEARCHED (Int. Cl.5)

G 09 F 9/00
G 09 F 13/00
G 02 B 6/00
G 09 G 3/00

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
VIENNA	16-11-1992	BRÄUER

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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